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On the Formation of the Flower Buds of Spring-Blossoming Plants During the Preceding Summer.

By Aug. F. Foerste.

For a number of years it has been an interesting subject for me to dissect the scale-protected, and usually subterranean, winter buds of plants blossoming in the spring, in order to ascertain the earliest date at which the *flower* buds of the *coming* season can be discerned. Having recently had unusually good opportunities for continuing these studies, I present here a part of the results.

The first set of observations were made in the vicinity of Rutland, Vermont, in the district lying between the Green Mountain and the Taconic ranges, during the middle of August. *Sanguinaria Canadensis* then had the flower bud considerably developed, being at least an eighth of an inch long, and containing all the elements of the future blossom in easily recognizable form. *Fragaria Virginiana* showed a cluster of flower buds, the largest of which was a sixteenth of an inch long, the entire cluster being so densely covered with close villous hairs as not to admit of easy recognition of its true character. In *Cornus Canadensis* the flower bud cluster could be readily distinguished, the buds being a thirty-second of an inch or less in diameter. *Pyrola elliptica* has a scaly bud which is not subterranean. The scales being removed, the tiny raceme of flower buds comes to view. Many of the buds have a diameter of less than a fortieth of an inch. *Asarum Canadense* has scaly buds which usually lie flattened close to the ground, covered by fallen leaves, but not subterranean. The enclosed flower bud is about an eighth of an inch long, showing all the structural elements distinctly, although in a miniature form. *Liparis Læselii* has solid bulbs, toward one

side of which, subtended by the inner of the two root leaves, is a small scaly bud, containing the flowering scape of the coming season, the buds of which are so minute as only to be discernable with the aid of a lens. *Smilacina racemosa* shows the terminal panicle, only the lower buds of which can be distinguished even with the aid of a lens. *Maianthemum Canadense*, however, presents these buds in much more recognizable form, being at least a thirty-second of an inch in diameter. *Clintonia borealis* has a scaly bud at the end of a root stalk, usually at least six inches long. In this bud are found the flower buds of the next season distinctly formed in all their parts. Some of the buds slightly exceeded a sixteenth of an inch in length. Nevertheless, the parts were sufficiently well formed to permit me, who not living near its haunts, was up to that time ignorant of the systematic position of the plant, to analyze these flowers which were to blossom next spring sufficiently well to correctly determine its Liliaceous character, and thus to permit its identification. *Trillium erythrocarpum* possessed flower buds a quarter of an inch long and all its parts distinctly developed. *Arisæma triphyllum* presented the so-called "flower" in well developed form, an eighth of an inch long. The spathe was as long as the spadix, and on the latter the minute female elements could be readily detected.

The second set of observations were made during the middle of September, in the vicinity of Mt. Greylock, Berkshire County, Massachusetts. At the northern end of the Bellows Pipe Valley, *Caulophyllum thalictroides* was found, containing in a scaly bud the leaves for the next season's growth, and a dense cluster of tiny buds, about a fortieth of an inch in diameter, and which were destined, when lengthened out, to form the loose panicle of next spring. *Mitella diphylla* reverses the rule in regard to the inflorescence of most spring-flowering plants, by being not directly terminal. The flower clusters are found in lateral elements of the scaly bud on opposite sides of a terminal leaf bud which forms the most important part of the scaly bud. In these lateral buds occur the two leaves which are usually formed half way up the scape of the plant, and the cluster of minute flower buds, rather covered with hairs, which were destined to terminate these scapes of lateral origin.

Along Le Chien's Creek, northeast of Berkshire, Mass., *Uvularia perfoliata* was found with the terminal flower bud at least a quarter of an inch long, and all its elements distinctly formed. *Aralia quinquefolia* showed the flower buds readily, especially when a lens of low power was used. The individual buds were a fortieth of an iuch or less in diameter.

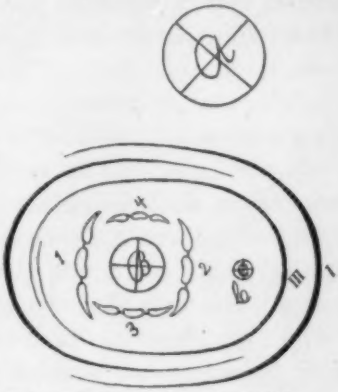

Diagram of *Aralia quinquefolia*.

The third set of observations were made in the latter part of September, between East Nassau, Renssellaer County, and Chatham, Columbia Co., both in New York State. *Thalictrum dioicum* contained the panicle of minute flower buds in recognizable form. *Epigæa repens* had scaly buds hidden among the moss but not covered by soil. On removing the scales, the small flower buds of the next season were readily discovered. *Chimaphila umbellata* also possesses a scaly bud which is not subterranean, but is found at the centre of the cluster of leaves terminating the little erect stalks rising directly from the ground. On removing these scales the minute flower buds can be readily discovered with a lens. *Cypripedium acaule* is another plant with which I had previously been unacquainted. On dissecting the subterranean scaly bud, I discovered two basal leaves and a large bract below the base of a flower bud, at least a quarter of an inch long. The two perfect anthers, on either side of a third sterile one with dilated tip, above the stigma, showed that the specimen was one of the Cypripedieæ, and the inflated, sac-like lip, already distinctly formed suggested that it was a true *Cypripedium*; whereas the two basal leaves, and the scape-like character of the rest of flowering stem, identified the species as *C. acaule*. In this way, I think it would be readily possible for any one already familiar with the general structure of flowering plants to identify many of the earlier perennial spring-flowering forms out of their season, by means of the flower buds destined to blossom first the ensuing year. *Streptopus roseus* has subterranean scaly buds which when dissected show the leaves of next year,

and the extra-axillary flower bud of that season, but at the time examined only a twenty-fifth of an inch long.

In some of my previously published notes I have mentioned similar facts in regard to part of the species cited above, and also other additional varieties. In the January number of the Botanical Gazette of 1883, "The Hibernaculum of *Asarum Canadense*" was described. A paper on "The Hibernacula of Herbs" was published in the November number of the American Naturalist, of 1883. In this paper *Asarum Canadense*, *Arisæma triphyllum*, and *Sanguinaria Canadensis*, were described. In addition to these, the early appearance of flower buds in other spring plants, so far not mentioned in the present article, were noted. *Anemone Hepatica*, *Jeffersonia diphylla*, *Diclytra Cucullaria*, *Claytonia Virginica*, *Uvularia grandiflora*, *Trillium sessile* and *Symplocarpus fætidus*. Most of these observations were unfortunately made as late as the middle of winter, extending into March, and therefore do not have the value of those taken this year in August and September, but judging from the strongly developed character of the flower buds of these plants when examined, I should judge that their initial stage could be detected much earlier. In the March number of the BULLETIN for 1884, in "The Development of *Dodecatheon Meadia*," the early development of the flower buds of that plant is described. An article entitled "Some Morphological Notes on *Caulophyllum thalictroides*," in the July number of the BULLETIN for 1887, gives some general views on the questions here involved, and is, I hope, substantiated by the additional facts now cited. "The Development of *Symplocarpus fætidus*," in the June number of the BULLETIN for 1888, gives a fuller description of the curious method of development and arrangement of the flower buds of that plant.

The total number of species investigated by me therefore is twenty-eight. All of these possess the same peculiarity of starting the formation of their flower buds during the summer of the previous year, and often attaining considerable development before the retarding influences of winter become effective. No doubt the warmer sunny days of winter permit still further growth, so that when spring has actually come, the increased warmth causes these flower buds to complete their development

rapidly, and to assume the tinted garb in which we are more accustomed to recognize them. The earlier blossoming plants, such as the Blood Root, Twin Leaf, Skunk Cabbage and *Trillium*, usually show their flower buds, in the fall, in a more advanced stage of development than those which flower later. The earlier flowering plants, also, as a rule have shorter stems and possess less foliage than those which blossom later. Perennial plants which do not develop flowers until in late spring or during the summer, of course, also possess scaly winter buds; but these buds only contain the earlier developing leaves; the later leaves and the flowers, are not formed until the scaly bud has burst and the growth of the year has well begun.

The conclusion therefore seems to be, that many spring flowers owe their early development to a combination of circumstances, already determined during the previous summer. These are a decrease in the number of internodes, and hence also, of the leaves produced before the development of flower buds begins; and the early origination and rapid development of flower buds in their scaly covering before winter sets in.

It is probable, that as a rule, the ancestors of spring plants are to be sought in more southerly districts, where the length of the summer and the shortness of the winter season make elaborate winter scale protections for the buds less important. On the other hand, it has seemed to me that the change from a more southerly climate to a northern climate was not exactly calculated to produce spring-flowering plants. It would seem more reasonable to suppose, that as southern plants migrated northwards, the cooler climate would retard their period of flowering so as, at first, to make northern summer flowering plants of the earlier southern types. In the course of time they might adapt themselves to the cooler condition there found.

However, as a plant which had become accustomed to a more northern climate migrated southward, the reverse conditions would operate; and a plant which did not flower until early in the summer farther north, would immediately become a spring-flowering plant on being transplanted to a warmer climate. It is not likely that in the migrations of plants the tendency towards northward migration is very distinct, from the inclination to remain in their more congenial southern homes. However,

it is probable that in a general way northern plants, and spring-blossoming plants, are related; and that the causes which tend to produce the one, when exerted in a different way, also tend to produce the other. The result finds its expression in the Botanies, when the distribution of a spring-flowering plant is given as being from a certain line northward, instead of southward, as is apt to be the case of true summer-flowering plants.

It is very natural that the flower buds intended to blossom the succeeding spring should occasionally be prematurely developed by the warm weather towards autumn. Autumn flowering of fall plants has been mentioned so frequently by writers that I will give only two cases in point: *Cornus Canadensis*, found in flower at Rutland, Vermont, late in August; and *Fragaria Virginiana*, also seen in blossom, on Mt. Greylock, near North Adams, Massachuetts.

This, however, is a different phenomenon from the fall-flowering of spring flowers which keep up a desultory sort of flowering all summer, but are apt to blossom again freely in the fall; as is the case with dandelions, chickweed, and similar plants. In the case of the fall-flowering of violets, the fall blossoms are simply the more mature and typical continuation of a long series of flowers, which during the summer are represented only by stunted cleistogamous forms. Then again, many spring-flowering annuals are apt, in the fall, to be again brought to the point of flowering by very favorable weather, from seed which in the ordinary course of nature would have developed to the point of a flowering plant first, the succeeding spring. The cases of the Cornel and Strawberry referred to above, are however, instances of premature development of a flower bud which was already in existence in accordance with the ordinary laws of nature.

Having shown that the development of the flower buds of spring plants, during the previous summer and autumn, was quite a common occurrence, it becomes important now to investigate the life history of certain early spring-blossoming perennials, such as *Dentaria laciniata*, *Erigenia bulbosa*, and *Isopyrum biternatum*, which, although flowering early in the season, do not seem to have the flower buds even started in the winter buds so far examined.

An Enumeration of the Plants Collected by Dr. H. H. Rusby in South America, 1885-1886.—XVI.

(Continued from p. 38.)

MANETTIA (?) DIFFUSA, sp. nov. Ramulis gracillimis glabris, teretibus; foliis gracile petiolatis, ovatis tenuis glabris acutis vel acuminatis, 5-6 cm. longis, basi obtusis vel cordatis; inflorascentia axillari et terminali, cymosa-paniculata; pedunculis pedicellique gracillibus, glabris; bracteis minutis; corolla 6mm. longa, cylindracea, tubus basi constricta. Resembling *M. paniculata*, Pœpp. and Endl. in habit but very different from that plant. Guanai, 2,000 ft. (2121).

Cosmibuena obtusifolia, R. & P. Fl. Peruv. iii. 3. Mapiri, 2,500 ft. (2103).

Condaminea corymbosa (R. & P.), D.C. Prodr. iv. 402. Yungas, 6,000 ft. (1898).

Chimarrhis, sp. Yungas, 6,000 ft. (2446).

Chimarrhis, sp. Same locality (2447).

Pogonopus tubulosus (D.C.), Schum. in Mart. Fl. Bras. vi. Pars. vi. (2), 265. Guanai, 2,000 ft. (2090).

Warszewiczia coccinea (D.C.), Klotzch, Mon. Ber. Akad. Wiss. Berl. 1853, 496. Guanai, 2,000 ft. (1953); Yungas, 6,000 ft. (1954); Falls of the Madeira, Brazil (1955).

Sipanea pratensis, Aubl. Guian. i. 147. (*S. hispida*, Benth. Hb. Kew). Mapiri, 2,500 ft. (2461).

Oldenlandia herbacea, D.C. Prodr. iv. 425. Falls of the Madeira, Brazil (2156).

Isertia bullata, Schum. loc. cit. 286 (?). Mapiri, 2,500 ft. (1895). I have not seen the type of Herr Schumann's species described as having cordate leaves. The leaves of our plant are narrowed at the base, otherwise much like those described by him.

Sabicea cana, Hook. f. Ic. Pl. t. 247. Mapiri, 2,500 ft. (1905).

Sabicea aspera, Aubl. Guian. 194, t. 76. (*S. hirsuta*, H.B.K.) Guanai, 2,000 ft. (1897); Mapiri, 2,500 ft. (1904).

Coccocypselum canescens, Willd. ex. Cham. & Schlecht. Linnæa, iv. 139. Yungas, 4,000 ft. (1397); Mapiri, 2,500 ft. (1896); Falls of the Madeira, Brazil (2099).

COCCOCYPSELUM MACROPODUM (R. & P.) (*Psychotria macropoda*, (R. & P.) Mapiri, 2,500 ft. (2098).

COCCOCYPSELUM GLABRUM. sp. nov. Herba ascendens, caulibus acutangulis glabris, 15-20 cm. altus. Petiolus 1 cm. longus; stipulæ subulatæ; folia ovato-lanceolata, acuta, basi obtusa, 4-6 cm. longa, 2-3 cm. lata, glabra; inflorascentia capitata, 5-10 mm. diametro; pedunculus 2 cm. longus; bacca 2 mm. diametro.

Yungas, 4,000 ft. (2479). The same as Matthew's Nos. 850 and 1943 from Peru, Herb. Kew.

Hamelia patens, Jacq. Stirp. Amer. 74, t. 50. Mapiri, 5,000 ft. (2105).

HOFFMANNIA BRACHYCARPA, sp. nova. Ramis adscendentibus vel erectus obtusangulis; foliis breve petiolatis vel sessilibus, obovatis, apice acuminatis basi cuneatis, supra glabris, subtus minute ferrugineo-pubescentibus, 20-30 cm. longis, 7-8 cm. longis, margine integris; inflorascentia axillaris, pedunculi gracili, 2 cm. longi; corolla ovarium aequale; bacca 2½ mm. longa 2 mm. lata. Yungas, 4,000 ft. (2522).

Bertiera Guianensis, Aubl. Guian. i. 180, t. 69. Guanai, 2,000 ft. (2118).

Posoqueria longiflora, Aubl. Guian. i. 134. t. 51. Junction of the Rivers Beni and Madre de Dios (2220).

Basanacantha spinosa (Jacq.), Schum. in Mart. Fl. Bras. vi. Pars. vi. 2, 376. Junction of the Rivers Beni and Madre de Dios (2157) (*Randia glabrescens*, Spruce).

Genipa Americana, L. Sp. Pl. Ed. 2, 251, var. *latifolia*, Spruce, Herb. Kew. Junction of the Rivers Beni and Madre de Dios (1899).

Chomelia paniculata, Benth. in Herb. Kew. Junction of the Rivers Beni and Madre de Dios (1878); Mapiri, 2,500 ft. (2117).

Chomelia, sp. Falls of the Madeira, Brazil (1490). I determined this at Kew as "*C. pubescens*, Benth" but there is a *C. pubescens*, C. & S. described in Schumann's Rubiaceæ of the Brazil Flora, p. 36, with which the plant does not agree.

Chomelia, sp. Guanai, 2,000 ft. (2659).

Coffea Arabica, L. Unduavi, 8,000 ft. Cultivated. (1900).

Coussarea, apparently undescribed. Junction of the Rivers Beni and Madre de Dios (2402).

Coussarea, sp. Beni River (2677) collected in fruit only.

Coussarea? Mapiri, 2,500 ft. (2559). The same as Fendler's No. 1990, from Tovar, Venezuela.

Faramea salicifolia, Presl. Symb. Bot. 24, t. 70. Yungas, 6,000 ft. (1869); Unduavi, 8,000 ft. (1870); Mapiri 2,500 ft. (2120), (2626), the later collected in fruit and referred to this species witn some hesitation.

Faramea Montevidensis, D.C. Prodr. iv. 497. Junction of the Rivers Beni and Madre de Dios (1874).

Faramea breviflora, Benth. in Herb. Kew. Falls of Madeira, Brazil. (2571.) Name not in Schumann's Rubiaceæ of the Brazil Flora.

Psychotria alba, R. & P. Fl. Peruv. ii. 58, t. 205. (*Mapouria alba*, Muell. Arg). Yungas, 4,000 ft. (2110) (1866); Guanai, 2,000 ft. (1889); Junction of Rivers Beni and Madre de Dios (1877) (1875).

Psychotria Casiquiaria, Muell. Arg. in Schum. Mart. Fl. Bras. vi. Pars v. 324. Mapiri, 2,500 ft. (2109). The same as Spruce, Rio Negro, No. 3436.

Psychotria lupulina, Benth, in Hook. Journ. Bot. iii. 230. Falls of the Madeira, Brazil (1873); Beni River (1872).

Psychotria brachybotra, Muell. Arg. in Schum. loc. cit. 327. Yungas, 6,000 ft (1887). The same as Spruce, Rio Negro, No. 2190.

Psychotria barbiflora, D.C. Prodr. iv. 509? Mapiri, 2,500 ft. (2112). Specimens too old for certain determination.

Psychotria Marcgravii, Spreng. Syst. Cur. Post. 79. Yungas, 6,000 ft. (1893).

Psychotria Paraensis. Muell. Arg. in Schum. loc. cit. 244. Falls of Madeira, Brazil (2114).

Psychotria brachyloba, Muell. Arg. loc. cit.? Mapiri, 5,000 ft. (1864).

PSYCHOTRIA CHIONANTHA (D.C.) (*Palicourea chionantha*, D.C. Prodr. iv. 526; *Psychotria Luschnathii*, Mart. Herb. Fl. Bras. 311). Mapiri, 5,000 ft. (1883).

PSYCHOTRIA BRACHYPODA (Muell. Arg.) (*Mapouria brachypoda*, Muell. Arg. in Schum. loc. cit. 422). Mapiri 2,500 ft. (1882). The same as Burchell's No. 3318 from San Paulo, Brazil.

Psychotria flexuosa, Willd. Sp.Pl. i. 966. Mapiri, 5,000 ft. (1884).

Psychotria racemosa, Willd. Sp. Pl. i. 966. Mapiri, 2,500 ft. (1867).

Psychotria tabacifolia, Muell. Arg. loc. cit. 236. Mapiri, 2,500 ft. (1880).

Psychotria viridis, R. & P. Fl. Per. t. 210. Guanai, 2,000 ft. (2515). The same as Matthews, No. 1949, Peru, Herb. Kew.

PSYCHOTRIA CROCEA (Schlecht.) *Palicourea crocea*, Schlecht, Linnæa, xxviii. 525 Beni River (2116).

Psychotria pilosiuscula, Griseb. Mapiri, 2,500 ft. (2480).

Psychotria crassa, Benth. Mapiri, 2,500 ft. (2113).

Psychotria cornigera, Benth. Yungas, 4,000 ft. (1865; 1881).

Psychotria, near *P. venulosa*, Muell. Arg. Falls of Madeira, Brazil (1879).

Psychotria near *P. idotricha*, Muell. Arg. Mapiri, 2,500 ft. (2489).

Psychotria leiocarpa, C. & S. Linnæa, 1829, 22. Guanai, 2,000 ft. (2161).

PSYCHOTRIA NIVEO-BARBATA (Muell. Arg.) (*Mapouria niveo-barbata*, Muell Arg.; Schum. in Mart. Fl. Bras. vi. Pars. vi. 2. 401). Mapiri, 2,500 ft. (1886). The same as Glaziou's No. 7684 from Rio Janeiro, Herb. Kew.

PSYCHOTRIA UMBROSA (Muell. Arg.) (*Mapouria umbrosa*, Muell. Arg. Flora 1876, 459). Mapiri, 2,500 ft. (1868). The same as Spruce's No. 660, Herb. Kew.

Psychotria. Guanai, 2,000 ft. (2558).

Psychotria. Mapiri, 2,500 ft, (1894).

Psychotria (?) Yungas, 6,000 ft. (1885).

Psychotria. Junction of the Rivers Beni and Madre de Dios (2575).

Psychotria. Mapiri, 2,500 ft. (1871).

Psychotria tomentosa (Willd.), Muell. Arg., Schum. loc. cit. 370. Mapiri, 2,500 ft. (853); Mapiri, 5,000 ft. (854; 855).

Rudgea micrantha, Muell. Arg. Flora, 1876, 454. Falls of the Madeira, Brazil (2108).

Rudgea Amazonica, Muell. Arg. loc. cit. 449. Junction of the Rivers Beni and Madre de Dios (1890).

Rudgea Hostmanniana, Benth. Yungas, 4,000 ft. (1888; 1892). Mapiri, 5,000 ft. (1891).

Rudgea. Mapiri, 2,500 ft. (1876).

The Fertilization of Three Native Plants.*

By E. G. Hill.

I.—*Campanula aparinoides*, Pursh.

It is well known that species of *Campanula* are adapted to cross-fertilization by the agency of insects, the flowers being proterandrous. This was clearly worked out and described by C. Sprengel in his famous book, the pioneer of work in this line, published at Berlin in 1793†. The illustrations in the plates (Taf. 9, 11.) accompanying the letter-press are good representations of what may be seen in species figured there, or in those allied to them. Hermann Müller, in his two principal works on the fertilization of flowers by insects‡, enters into their structure and adaptations with considerable detail, and with careful analysis, giving examples of several species and full illustrations in typical cases. All follow the same general plan, the individual variations being slight, since the species conform to a type more uniformly than genera usually do, as is also the case with the allied genus *Phyteuma*. The whole arrangement is very curious and interesting, being well planned to secure the designated end. *Campanula aparinoides*, Pursh, does not differ in any essential point of structure from the other members of the genus. The nectar, which is the object sought by visiting insects, is stored in a yellowish, fleshy disk, resting on the pistil and surrounding the base of the style. The disk is nearly covered by the enlarged bases of five filaments, termed "valves" by Sprengel, quite triangular in shape in *C. rotundifolia* and some other species, and rather elongated triangular in *C. aparinoides*. The five free spaces between these "valves" or enlarged bases of the filaments, are themselves nearly closed by interlocking hairs, projecting from the edges of the filaments.§ In *C. aparinoides* there are also hairs projecting from the inner side of the corolla at its base, and directed inwards towards the filaments. In the bud, and during the early stages of its development, the anthers, like a hollow

* Read before the State Microscopical Society of Illinois, Dec. 12, 1890.

† Das entdeckte Geheimniss der Natur im Bau und in der Befruchtung der Blumen, pp. 109-112.

‡ Die Befruchtung der Blumen durch Insekten, und Alpenblumen.

§ H. Müller, Befruchtung, p. 373.

cylinder, are closely wrapped around the upper part of the style, which is shaped like a hairy, cylindrical brush. The anthers burst along their inner face at this time, and the brush, by means of the bristling hairs, sweeps the pollen out of them pretty cleanly. As they shrivel up and shrink away towards the bottom of the bell-shaped corolla, the style lengthens, bearing the spherical pollen grains with it while the flower is unfolding. The stigmas are still inaccesssible to the pollen, since they form the inner faces of the three-cleft style, the parts of which are closed on one another, and form the cylindrical brush. They soon open and curve backward, exposing their inner surfaces, now turned outward and covered with stigmatic papillæ. As they curve back, they hold the same position in the flowers as did the brush a little earlier. Hence an insect, creeping into the corolla to reach the nectar, rubs off some pollen from the brush of a younger flower and carries it to the stigma of an older one, the parts of the style being curved back in such a way that it cannot, if of any considerable size, avoid brushing off some of the dust and leaving it on the papillose stigmas. In this way, as an insect goes from flower to flower, the ovules of an earlier flower are fertilized by the pollen of a later one.

The older botanists were puzzled to account for the fertilization of these plants. The relative position of the parts was well known to Linnæus and his pupils. In a dissertation by one of them, Wahlbom, entitled, "Sponsalia plantarum," and read at Upsal in 1746, it is stated that certain canals existed in the style to carry the pollen through to the stigmas.* Sprengel remarks that they did not see these canals, but imagined them. It was an effort to bridge a difficulty, and, like many another, broke down when the test was made.

The function of the hairs fringing the bases of the stamens is considered by Müller to be that of keeping useless visitors from the nectar stored in the fleshy disks just within. Strong insects like bees, that are the most common visitors of *Campanulæ*, can push through them and secure the nectar, the nectar-disks being covered by them and the "valves." Weak insects will be kept away. Sprengel looked upon them as contrivances to protect the

* Linnæus, Fundamenta Botanica, 1786, Vol. I, p. 246.

nectar from the rain, by preventing the entrance of drops of water, but this is thought to be useless by Müller on account of the inverted position of the flowers, actually causing them to be sought by insects as a shelter from rain and dew, and so facilitating their fertilization by these casual visits. But they would not be useless for this purpose in the case of *C. aparinoides*, whose flowers open upward, they being nearly erect on their slender stems.

There are plenty of guests, bidden or unbidden, in the flowers of the Marsh Bellwort. Nearly every one has a goodly number of Thrips, (*Palæothrips*, Sp.), crawling about in various parts of it, and busy at something. Sprengel states that they were the only insects he had seen in the species of *Campanula* he mentions, five in all including *Specularia*, but he thought that they could hardly affect fertilization, and that this must be done by some larger insects. Among the insects mentioned by Müller, nothing is said of Thrips. But it seems evident that they may be useful in the case of *C. aparinoides* from a study of the flower and its surroundings. These do not, as already intimated, like species with inverted corrollas, offer shelter to the bees and other insects at night or during rain. Though the flowers are white or bluish-white, they are neither conspicuous nor very accessible, since they are usually down among the blades of grass where they most delight to grow. Sometimes they stretch upward and offer inducements of this kind, which may also be both a cause of superior vigor and a result of insect visitation. But the Thrips are the only insect visitors I find at all common. Others are occasionally seen, small butterflies and moths and bee-like flies, and they not alighting very often. When the Thrips are placed upon a slide and examined, they will be seen to be plentifully sprinkled with spherical grains of pollen, adhering to various portions of their bodies, especially to the antennæ and the body-hairs. They crawl around in the base of the flowers, and over the style and stigmas. They appear too small to go from one flower to another to any extent, and especially from one plant to another, though this is not impossible, since the plants sometimes grow so closely together as to be grasped by the hand and pulled up by the handful. But it is not probable that fertilization is effected in this manner to any degree.

But it may be the office of these tiny insects to effect self-fertilization in flowers that do not often receive visits from larger insects, for whose visits they are, however, functionally contrived. They bring about results which, though inferior, are greatly superior to failure of pollenation. Though the flowers are proterandrous, the round and unbroken grains of pollen are still visible on the outer side of the style some time after its parts have expanded and exposed the stigmatic surfaces. The Thrips will be useful in carrying this pollen across to the other side, and in this way overcome a difficulty which the pupil of Linnæus imagined must be obviated by his supposed canals.

Both the ability and desirability of self-fertilization in case of a lack of insect-visitation have been recognized by Müller and other writers as probable in species of *Campanula.** He indeed calls it a makeshift (möglichkeit), but as such it is far better than failure in accomplishing the development of seed. He mentions *C. barbata*, L., as an example of this kind, where, if cross-fertilization fails, self-fertilization may take place. The method of securing this is for the parts of the style to curve around till their stigmatic faces come in contact with the lower part of the brush formed by the undivided portion of the style, or by the pollen falling on the stigmas when they are in this position. The parts of the style would have to curve into a circle to bring the two sets of hairs, those on the brush and those on the stigma, into this relation. But they do not appear to curve so far in the flowers of *C. aparinoides*. This condition of affairs also implies that the pollen of a flower is available for its own fertilization when the parts of the style expand and long enongh afterward to allow them to curve to make the required contact. And this is corroborated by finding fresh pollen on the brush and on the Thrips, which, though it might have been brought from other flowers, is more likely to have been left for use by their own anthers. And it seems much easier and more satisfactory to make the Thrips

* "The *Campanulaceæ* have been inquired into by many investigators as a supposed case of necessary self-fertilization, some of whom, Cassini, Treviranus, Hartig, and Gaertner, decide for it; others, Sprengel, Wiegman and Henschel, against. According to my investigations, which, however, are to be extended by more exact experiments, self-fertilization does not take place."—Hildebrand, Geschlechter Vertheilung bei den Pflanzen, p. 64, (Leipzig, 1867.)

pollen carriers than for the parts of the style to curve around and gather their own pollen, functionally intended for the use of other flowers. Viewed in this manner they would not be termed useless guests, or be classed among the insects engaged in petty thefts* (Diebstähle) while busily crawling about among the hairs of the Marsh Bellwort, which they do so easily, but among those lawfully employed in proper work.

II.—*Sabbatia angularis*, Pursh.

This handsome member of the Gentian family is a common plant in many of the damp places of our pine barrens, blooming in late summer and early autumn. But its floral beauty is not its sole feature of attraction. The mechanism to secure cross-fertilization by the help of insects is still more interesting. The flowers, like others of the genus, are proterandrous, and skillfully contrived to secure this end. They have a wheel-shaped corolla, rose-pink in color, very bright and attractive to the eye. At the base of its short tube is a yellow or greenish-yellow spot, shaped somewhat like a star with five short, blunt rays, bordered by a dark red or purple band, contrasting sharply with the general color of the flower. The style is bent downward and outward, bringing it to one side of the flower, or away from the floral axis. It is deeply two-cleft; occasionally three cleft. In the bud the corolla is dextrorsely convolute. The style and its parts share in the same spiral movement seen in the twisting of the bud, it being sinistrorsely twisted. The two parts of the style face each other, their inner surfaces stigmatic for the greater part of their length and thickly covered with glandular hairs. These parts are closed in the bud, and until after the anthers burst. The bending of the style is in a plane parallel with the cleft, or away from which the two parts of the style would recede at a right angle if they were not twisted. This would leave the stigmas with their edges only presented to the body of an insect at work above or below them, unless they spread considerably, so as to allow it to pass through the fork between them, which is not the case. But the twisting, owing to the length of the parts, tends to hold them together, as a cord is twisted to bind its threads better. Yet it

* Müller, Befruchtung der Blumen, p. 373.

compensates in a measure for this by bringing a good part of the stigma to the upper side of the style, so as to rub against the body of an insect trying to reach the nectar in the most advantageous way. For, in looking at a flower from the outside, the twisting is seen to be towards the left hand. The style makes a turn, bringing that part of the fork axially on the right over to the left. Since the cleft extends about half way down, this part of the fork, in the effort to withdraw from the other and turn at the same time, rolls its inner face upward for a good portion of its length, being still held to the opposite part at the upper end; and turning it wholly upward, except at the tip (which may have turned too far for this), in case it is released. By the same process, the part of the fork axially on the left passes over to the right, much of the inner surface being turned downward. Sometimes the tips of the parts in either case may turn so far as to bring the ends of the stigmas upward or downward, and opposite to the position of their main parts respectively. This is a great advantage, by making the larger part of the stigmatic surfaces easily accessible, since the parts of the style diverge but little when they succeed in separating, for the interlocking is often quite strong. The erection of the style, a characteristic of species of *Sabbatia* in later anthesis, is not a prominent feature of *S. angularis*. In fact, when it occurs, it is of no special advantage for cross-fertilization in this plant, the stigmas being well exposed while the style is turned to one side. Fertilization may thus begin at an earlier stage, with fewer chances of failure, should the parts remain locked together. Besides, the style, being quite stiff, when turned to one side offers a better landing-place to a large insect, by affording more room on one side of the corolla of a flower not very broad.

The object of these visits is to get the nectar stored in receptacles attached to the base of the ovary. These project outward and downward as little swellings, each nectary opposite a petal and to a point of the star forming the eye at its base. Hence they alternate with the stamens, which are of the same number as the lobes of the corolla and opposite its clefts. It is between the filaments that an insect would run its proboscis to reach the nectar-glands, the bright line raised up into blunt points exactly

opposite them serving as a guide. The tube of the corolla is about as long as the ovary. The style and ovary are green. The anthers are introrse and adnate, though the point of attachment to the filament is a little above their base, making them slightly versatile, so far at least as to turn back with facility. At the time of bursting they bend back, becoming arcuate in shape and open upward. When an insect lights upon a flower and turns about in the effort to reach the various nectaries, these anthers are favorably situated to leave the pollen on its under side. The stigmas of the flower being closed on one another are not yet in a condition to receive this pollen, except a small quantity which may be left on the few hairs that project from the edges of the cleft. But when an older flower is subsequently visited, it will have its stigmas turned in the proper way for the reception of the grains. Working about the flower to obtain the nectar, all parts of the exposed stigmas are likely to come in contact with some part of the insect to which pollen adheres, and the grandular stigmatic hairs will rub it off and hold it. In this way cross-fertilization will be effectually secured.

The structure and mode of bursting of the anthers is an additional help in this process. By curving they are made stiff, and their walls are stretched. The tissue of the cell-walls is very elastic. While experimenting with the anthers to see how they opened, one was pressed along its sides between the prongs of a pair of forceps. The instrument suddenly slipped, and the shock, or relief from pressure, was so great that the cells burst, quickly throwing out the pollen to quite a distance. Repeating the experiment and imitating the first operation as nearly as possible, others were ruptured in the same manner. Sometimes the elastic force was so great as to nearly empty the cells by a single effort. Doutless an insect will also exert a like pressure, by grasping the anthers with its feet or pressing them between its legs while at work upon the flower, and cause their bursting in a similar way. As a result the pollen will be shot against its body, and more adequately dust it than by a simple act of rubbing against them. The tissues of the cells being stretched and the anthers bent into the form of a bow, as soon as they are unloosed, shoot out their tiny missiles, stored up within, and hit their insect guests, not as enemies, but as agents of the plant in furthering its economy.

III.—*Eleocharis mutata* (L.) R. & S.

This plant was detected during the present season in Wolf Lake, along the eastern border of Chicago, and near the boundry line of Indiana. It grew in abundance but had hitherto escaped the notice of collectors in this vicinity, as I find no allusions to it in this locality. An examination of its flowers showed that they were proterogynous, the protruding style and stigmas being brown and withered while the stamens are still covered by the scales. A further study of the plants showed that the styles appear above the scales just after the spikes have risen out of the water from one to three or four inches. When the plants have stretched upward from six to twelve inches beyond their proterogynous stage, the anthers make their appearance above the scales. The spikes are about an inch in length at first, but increase in length and diameter as they become older, or reach their second stage. Then the anthers burst, and freely scatter the dry pollen about, some of which will lodge on the feathery stigmas. The plant is fertilized by the wind, or even by simple gravity, since the stems are near together, several rising from the same rhizome. The elevation of the spikes when the stamens appear, bringing them above the younger flowers in which the stigmas are ready to receive the pollen, facilitates its reaching them at a level so much below, since it may simply drop upon them. But the wind, either directly or by agitating the water and shaking the stems, must be regarded as the principal agent in the cross-fertilization of the flowers. The inflorescence of the spikes is centrifugal, the older stamens being mostly above. Belated stamens sometimes appear without anthers. They rise above the scales as pale elongations of filaments, a little enlarged at the top.

ENGLEWOOD, CHICAGO.

Variations in the Rootstock of Smilax glauca dependent upon Environment.

On the south beach of Staten Island, at the line of high water, there are often a number of hard, gall-like bodies, lying on the sand. These are sea-worn parts, often single tubers, from the rootstock of the cat-brier, probably in every case from *Smilax glauca*. This species grows on the bluffs that are constantly

breaking away, and by this and other means, sections of the root-stock finally reach the beach and are worn by the waves until the tough roots, that have their origin particularly in the tubers, are reduced to spine-like processes.

Smilax glauca not only grows on sandy bluffs and dunes, but also in low land, that for a portion of the year is quite wet. These conditions produce their effect upon the plants, and those occupying the dry and sandy places are not, in every particular, like those that have grown on moister ground. There is not only the usual difference between plants that grow on dry places and on damp ones, namely: a difference in depth of root, but there is also a variation of growth, which is evidently useful and adapted to environment.

The rhizomas of *Smilax glauca* are always tuberiferous, the tubers being occasionally connected to the rootstock at one end only, but generally they are swellings, sometimes of single nodes and sometimes of several nodes coalesced, that form along the rhizoma itself, and are centers of collected nourishment. Many of the upright leaf-bearing branches, as well as the main and more robust roots, are connected with these tubers, and when the tubers consist of several coalesced nodes, the roots grow from them in circles of some regularity, but the coalescence is also plainly seen in some instances, without the aid of the accompanying roots.

The change of growth with change of condition, mentioned above, is especially noticeable in these tubers, which appear to be more numerous on plants growing on dry, sandy stations, to have a greater number of roots starting from them and fewer from the internodal spaces, and also to be often of larger size, than on plants occupying moister situations. This is easily explained, for they have more need of stored moisture and nourishment than those of the low, wet ground. Also in these latter plants the spaces between the nodes are greater than in those occupying the dunes.

WM. T. DAVIS.

An Undescribed Desmodium from Texas and Mexico.

DESMODIUM LINDHEIMERI.—Erect, branching, stout, 2° or more high, conspicuously angled and channeled, downy with a close fine pubescence; stipules more or less persistent, ovate lanceolate, cuspidate, pubescent and reflexed; petioles 1′ or more long; leaflets scabrous or finely pubescent above, reticulate, villous-pubescent and the veins conspicuous beneath, ovate or ovate-lanceolate, 1-3′ or more long, the terminal one mostly somewhat rhomboid, truncate at the base, acutish, the two others inequilateral, smaller and more obtuse; racemes panicled, spreading; bracts ovate-lanceolate, cuspidate, deciduous; flowers purple; calyx bilabiate, the lobes acute and nearly equal; loment 1′ to 1½′ or more long, 4-6 jointed, the joints obliquely oval, about 4″ long and 3″ wide, glabrous with the sutures conspicuously uncinate-pubescent; stipes 1″ or less long.

Monterey, Mexico, Herb. Kew, coll. by Dr. Edwards; (Hemsley Biol. Cent. Am. i., 291,) also in Herb. Torrey (without fruit), determined by Bentham as *Desmodium viridiflorum*, Beck.

New Braunfels, Texas, coll. F. Lindheimer (No. 499). Caracol Mts., Mexico, coll. Ed. Palmer (No. 246). Mts. near Cardenas, Mexico, coll. C. G. Pringle (No. 3289). This plant differs from the typical *Desmodium viridiflorum* (L.) Beck, of the Atlantic Coast States in its angled stems, stouter habit, and the size and shape of the joints of its loment. Those of *D. viridiflorum* are rarely more than 2″ long, semi-rhomboid and uncinate pubescent throughout, whereas those of *D. Lindheimeri* are fully twice that size, obliquely oval, glabrous with only the sutures uncinate-pubescent. In the more recently collected and beautifully prepared specimens of C. G. Pringle the joints are green with the pubescence on the sutures appearing perfectly white. The alliance of Lindheimer's plant is rather with *Desmodium canescens* (L.) D.C. than with *D. viridiflorum*.

ANNA MURRAY VAIL.

Plants of Special Interest Collected at Orono, Maine.

By MERRITT L. FERNALD.

Although Orono and vicinity have long been considered among the best collecting fields in Maine, both for the botanist and the entomologist, yet very little has been published concerning our flora. This is doubtless due, in a large degree, to the lack

of local botanists. Nearly all who have spent any time here have been connected with the State College, and their necessary duties have left them little time for outside work.

It has been my privilege to spend the past year, 1890—especially from May to August—collecting here. Thinking that notes on some of our less common plants may be of interest, I venture the following. Plants marked * are not recorded from Maine in the sixth edition of Gray's Manual.

Clematis verticillaris, DC. Prof. Lamson Scribner in an article published fifteen years ago, stated that this plant was found in Orono, "growing profusely on rocky banks." It has fast been torn up, until now there are only a few straggling plants left, and these are in constant danger of meeting the same fate.

* *Nymphæa advena*, Ait. f., var. *minus*, Morong, is quite abundant at "Chemo," a pond and stream in Bradley.

Alyssum calycinum, L. Sparingly introduced into grass-land.

* *Papaver Rhaeas*, L. Ever since I can remember, this plant has grown in a field back of the old "White House" at the college. Probably at first escaped from a garden, but it has not failed to make its appearance for years.

Viola palmata, L., var. *cucullata*, (Ait.) Gray. A pure-white form is prevalent in a meadow on the "Old Town road."

* *Viola tricolor*, L. var. *arvensis*, Ging. Sparingly introduced with grass-seed.

* *Hypericum Canadense*, L., var. *minimum*, Chois. A form answering to the description of this is frequent in mossy places.

* *Poterium Sanguisorba*, L. A single plant of this was collected in cultivated ground, in 1889.

* *Epilobium hirsutum*, L. This occurs in at least one garden in Portland as a weed, where I collected it, in 1889.

* *Epilobium strictum*, Muhl. Not infrequent in bogs throughout the state.

* *Ribes nigrum*, L. Escaped into rich soil near the bank of the Stillwater River.

* *Callitriche verna*, L. Abundant in water and wet places, everywhere.

* *Callitriche heterophylla*, Pursh. Not very common.

* *Galium Mollugo*, L. Sparingly naturalized in fields.

Aster Lindleyanus, Torr. & Gray. Recorded only from Mt. Desert, in Maine. Very abundant in dry or moist fields, varying from 6-18 inches in height, and the heads often 1 or 1½ inches across. Our most beautiful species.

Anthemis arvensis, L. Nearly as common as *A. Cotula*, growing in fields and newly sown lawns.

Matricaria inodora, L. Fields, rare. Recorded from Eastport, Maine.

* *Matricaria discoidea*, DC. Abundant at one point on Main Street, south of Orono village. Immigrant from Oregon.

* *Centaurea Jacea*, L. One plant was collected in experimental grass-land.

* *Hypochœris glabra*, L. Experimental grass-land. Scarce.

* *Lactuca hirsuta*, Muhl. Not rare in low woods.

Vaccinium cæspitosum, Michx. There is a small patch of this alpine species on the bank of the Stillwater River, near the village of Upper Stillwater. Especially interesting on account of the altitude; about 100 feet.

* *Vaccinium cæspitosum*, Michx., var. *cuneifolium*, Nutt. Grows in profusion in one part of the pasture back of the college farm buildings. Not previously recorded east of Lake Superior.

* *Lysimachia thyrsiflora*, L. Not rare throughout the State.

Halenia deflexa, (Sm.) Griseb. Quite common in all low woods and pastures.

Veronica arvensis, L. Grows on wet rocks in a lot of woods near Veazie, appearing as if indigenous.

Veronica Buxbaumii, Tenore. Frequent.

* *Mentha sativa*, L. Occurs sparingly near the college farm-house. Probably introduced with garden seed.

Mentha arvensis, L. Grows sparingly on the bank of the Stillwater River.

* *Plantago Patagonica*, Jacq., var. *aristata*, (Michx.) Gray. A few plants have been collected in grass lands.

Polygonum Careyi, Olney. Very abundant in low or cultivated ground. Recorded from Southern Maine.

Salix balsamifera, Barratt. Stillwater River, near bank.

* *Narcissus poeticus*, L. This plant has grown wild in a field quite remote from buildings, ever since I can remember. It is constantly increasing, new plants springing up many yards away from others.

Juncus Greenii, Oakęs & Tuck. This is very abundant in an alder swamp. Of special interest, as it has hitherto been considered a coast plant, while Orono is nearly forty miles from the nearest salt water.

* *Juncus Canadensis*, J. Gay, vars. *longecaudatus* and *subcaudatus*, of Engelmann, are both common, the former growing in swamps and the latter on the sandy shores of a small pond, the procumbent form being very plenty. Coralline tubers were found on many plants of var. *subcaudatus*.

* *Carex aquatilis* × *stricta*, Bailey. This new form occurs in a meadow on the college grounds. It is strange that it has never been noticed before, as it grows on both sides of the main driveway to the college buildings.

* *Carex communis*, Bailey, var. *Wheeleri*, Bailey. In dry woods, but not common.

* *Carex chordorhiza*, Ehrh. (See Bull., Oct., 1890).

* *Carex echinata*, Murray, var. *angustata*, Bailey, and a form approaching var. *cephalantha*, Bailey. Both quite common.

* *Carex straminea*, Willd., var. *alata*, Bailey. Not uncommon along the line of the M. C. R. R. between Orono and Veazie.

Other *Carices* of note found here are: *pauciflora*, Lightf., *Pseudocyperus*, L., *Houghtonii*, Torr., *lenticularis*, Michx., *Magellanica*, Lam., *limosa*, L., *flava*, L., Vars. *graminis* and *viridula* of Bailey, *umbellata*, Schk., *deflexa*, Hornem, var. *Deanei*, Bailey, *canescens*, L., var. *polystachya*, Boott., common in ditches, *tenuiflora*, Wahl. *tribuloides*, Wahl., vars. *turbuta* and *reducta* of Bailey, together with sixty others.

Panicum xanthophysum, Gray. Scarce.

* *Danthonia compressa*, Aust. Not rare in dry woods.

Sporobolus cuspidatus, Torr. I found one plant of this in dry soil. Previously recorded from Northern Maine.

Apera spica-venti, Beauv. Not infrequent in dry or cultivated ground.

Poa nemoralis, L. Woods, rare. Recorded from Northern Maine.

* *Poa debilis*, Torr. Probably this species, though Dr. Vasey says the plant appears somewhat like *alsodes*, Gray. Deep mossy woods.

Puccinellia maritima, Parl., var. *minor*, Watson. I collected this rare form at Cape Elizabeth, Me., in 1889. Only two plants were found.

Festuca gigantea, Vill. Not rare by roadsides.

Aspidium spinulosum, Swartz. The typical form is common here in deep woods and swamps.

Ophioglossum vulgatum, L. Quite abundant.

* *Lycopodium*. Prof. D. C. Eaton names it, "*L. annotinum*, L., var. *pungens*, Spring, a form with the fertile branches less leafy, and thus imitating *L. clavatum*, L." Knolls in pasture. Very scarce.

Thus it is seen that Maine has an unusually interesting flora, the discoveries in which may be made almost indefinite in extent, and when there have been further explorations, doubtless many things will be found to occur here which have hitherto been overlooked by the busy people of the "Pine Tree State."

I wish here at least to express my thanks for the assistance so kindly rendered me and the encouragement given by four of our most prominent workers, Drs. Sereno Watson and Geo. Vasey, and Professors L. H. Bailey and D. C. Eaton.

Orono, Me.

Reviews of Foreign Literature.

La Génération sexuée des Gleichéniacées. N. W. P. Rauwenhoff, (Archives Néerlandaises xxiv. 157–231.)

The Gleicheniaceæ form a group of ferns having no representatives within the United States. They are usually placed between the Osmundaceæ and the other leptosporangiate ferns, and constitute a family of equal rank with the Polypodiaceæ, Schizæaceæ etc. They have been but little studied, and the paper before us is the first account of the prothallium that is at all complete, although the author in 1877 and 1879 published some notes upon them.

In the present paper the author treats at considerable length the germination of the spore and the development of the prothallium and sexual organs, and gives a few very brief notes upon the embryo.

The structure of the spores, and the first phases of germination are treated very minutely, and are briefly as follows: The ripe spores are destitute of chlorophyll, of a yellow color, and possessing a membrane that shows a differentiation into three layers, perispore, epispore, and endospore, none of which are composed of unaltered cellulose.

Shortly after sowing the spores chlorophyll is formed, and the spore membrane is ruptured, allowing the enlarging contents to protrude in the form of a papilla, which together with the rest of the spore contents, is now surrounded with a cellulose wall.

The early stages of the prothallum do not differ in any marked degree from those of other Leptosporangiatæ, resembling, perhaps the Osmundaceæ most nearly, especially in the not infrequent formation of a cell-mass as the first stage of the prothallium. The prothallium usually grows for some time by a two-sided apical cell, which is later replaced by a row of equal marginal initials, as in other ferns. Sometimes, as in the Osmundaceæ, a thickened midrib is formed very early, but usually the thickening is confined to the cushion back of the notch in front, as in the Polypodiaceæ. A tendency to form numerous lateral branches, capable of independent growth, and a multiplication of the prothallia by this means, is shared with the Osmundaceæ.

The development of the sexual organs, especially the archegonium, is not treated with as much care as could be wished. The antheridia, in their development, are midway between the Osmundaceæ and Polypodiaceæ but one or two statements made require confirmation. This is especially true of the statement that chlorophyll is found in the central cell of the young antheridium, as well as in the peripheral cells. This is certainly contrary to what obtains in all other investigated archegoniates, and as figure 58 of the memoir in which this is shown evidently represents a pathological case, as is evident from the collapsed condition of the central cell, the statement is probably incorrect. The account of the spermatozoids is also very confused, and the

impression is given that their whole development takes place after the escape of the sperm-cells from the antheridium, which, to say the least, is improbable. At any rate, no account is given of their origin and development beyond a very brief statement of the changes in the appearance of the sperm-cells from the time they are ejected to the escape of the spermatozoids, a period varying from one-quarter to one-half hour.

The development of the archegonium corresponds, so far as the somewhat incomplete account goes, with that of other ferns. The neck, to judge from the figures, as nothing is said in this point in the text, is straight, as in the Osmundaceæ and Hymenophyllaceæ. The number of canal-cells is not given, and no mention is made of a ventral canal-cell, although unquestionably one must be present.

The same vagueness is noticed in his treatment of the embryo. After stating that the first division-wall is slightly inclined to the axis of the archegonium and that the next divisions result in the formation of octants, as in the other Filicineæ, he says: "Peu à peu l'embryon devient un corps globuleux, à petites cellules, dans lequel.....la cellule triangulaire du sommet de la racine est la première à se différencier nettement."

Sometimes more than one embryo will begin to form upon the same prothallium.

A study of the growth of the root confirms Nägeli and Leitgeb's statements as to the origin of the primary tissues of the root, rather than the recent account of Van Tieghem and Doüliot.

While the paper is a valuable contribution to our knowledge of the ferns, it would have been quite as much so if a large part of the very tedious introductory matter were omitted; and it is much to be regretted that the account of the sexual organs and the embryo is not more careful and complete, as a comparison of these with other ferns might be of great value from a systematic standpoint. DOUGLAS H. CAMPBELL.

Assimilation of the Free Nitrogen of the Air by Leguminous Plants. In the Berichte der deutschen Bot. Gesellschaft of November last, Dr. Frank gives the result of an experiment on *Robinia Pseudacacia*. The soil for this purpose was pure quartz sand, first heated, then washed with water containing hydrochlor-

ic acid, then with pure water. To this was added a solution of nourishing material of a certain known composition, afterward the pots holding this prepared soil were placed in a steam sterilizer and heated for several hours. A slight quantity of soil, taken from the earth where *Robinia* trees grew under ordinary conditions, was then placed in each pot. This was to supply the young plants with germs of the supposed bacteria. Seeds were then sown, a single one in each pot, and the resulting plants kept in the hot-house and watered with distilled water. After the growth of a single summer the plants were examined and subjected to chemical analysis. All had developed the little tubers supposed to be caused by bacteria, and there were found in different conditions, some entirely emptied of contents, others yet tense, and hard with all intermediate stages. The chemical analysis showed the quantity of nitrogen contained in the plants to be something more than thirty-eight times that contained in the seeds. This nitrogen could have been obtained from no other source, it is claimed, than the free nitrogen of the air. In order to show more clearly the function of the tubers and their connection with the bacteria germs, a few pots were prepared without the earth from outside, but allowed to stand in the same room with the others. These plants also developed tubers, though less in number and less well developed, which Dr. Frank says could have come from no other source than the germs escaped from the other pots. Various precautions were taken to avoid this infection, such as covering the surface with cotton, etc., but the simpler method of removing the pots from the atmosphere surrounding the infected plants seem not to have been tried.

E. L. G.

Recherches sur la Vrille des Passiflores, par M. W. Russell. (Bull. Soc. Bot. de France, xxxvii. 189-192).

The rameal nature of the tendrils of the Passifloræ is well known, but their origin is a source of considerable discussion among botanists. According to various authors there exists in the axils of the leaves two or three organs, of which one represents the axillary branch, whereas the others are either accessory ramifications, or normal ramifications of the same or of a different order.

In this study of the tendrils of the Passifloræ, the author takes *Passiflora holosericea* as a type and observes—1st, a tendril it the axil of the leaf; 2nd, two floral pedicels *b* and *c* on either side of the tendril, but slightly behind it; 3rd, a leaf-bearing branch, and *a* situated between the tendril and the stem. Of all these organs the first to develop is the tendril, and when that has attained a certain size, a second bud appears in the angle of the tendril and the stem, which bud developes into the leaf bearing branch *a* and after that are formed successively the buds *b* and *c*, one at the right and the other to the left of the base of the tendril. It is to be noted that neither of these three buds possesses an axillary leaf, or even a rudimentary one.

The conclusions reached are that the tendril of the Passifloræ represents a modified axillary branch that can have at its base several secondary branches destitute of axillary leaves. The branch representing the first ramification is always developed, and produces either a branch with leaves which replaces the axillary branch transformed into a tendril, or a flora pedicel, either simple or branched. The other branches that are in the flowering portion of the plant become plural pedicels, or are only partly developed, or remain undeveloped. A. M. V.

Sulle foglie delle Piante acquatiche e specialmente sopra quelle della Nymphæa e del Nuphar. Nota di G. Arcangeli. (Nuovo Giornale Bot. Ital. xxii. 441).

In the above study on the structure of the leaves of *Nymphæa* and *Nuphar* the terms *idrophylli*, *æridrophylli* and *ærophylli* are suggested to designate respectively the submersed, floating and ærial leaves of aquatic plants. Under the group of *idrophylli* Sig. Arcangeli proposes to unite all the leaves that present structures adapted to thrive totally under water as do the leaves of the *Zosteraceæ*, some *Potamogeton*, *Vallisneria*, *Elodea*, etc.; under that of *æridrophylli* all the forms that float on the surface of the water, as in *Nymphæa* and *Nuphar*; and under the name of *ærophylli*, those that grow above the surface of the water, as do the leaves of *Sagittaria* and *Limnobium Spongia*.

A. M. V.

Key to the Genera and Species of British Mosses. Rev. H. G. Jameson. (Journ. Bot. xxix., 33-45, plate 302).

Beginners and students of mosses who do not recognize genera at sight will find this a useful guide, while even more advanced students will appreciate the ingenuity by which the key and its explanation is made to serve as an illustrated glossary. The terms used are as simple as accuracy will allow, and the key permits the analysis of sterile as well as fruiting specimens. The genera of the Hypneæ are separated, thus forcing a beginner to recognize differences which are as clear as those which separate genera of acrocarpous mosses. E. G. B.

Index to Recent Literature relating to American Botany.

Allamanda grandiflora. (Garden, xxxix. 192, 193, Pl. 794).

Anthracnose of Cotton. E. A. Southworth. (Journ. Mycol. vi. 100-105, Pl. iv. and figs. in text).

A new species is described and figured in this article, *Colletotrichium Gossypii*, which was originally distributed in Ellis' North American Fungi, as *Glœosporium carpigenum.*

Anthracnose of the Hollyhock—Additional observations on. E. A. Southworth. (Journ. Mycol. vi. 115, 116).

Reference is made to the apparent fact that this fungus was described in 1854 by Braun and Caspary as *Steirochæte Malvarum*, and the name *Collectobrichium Malvarum*, (Br. and Casp.), must therefore stand for it. The author also notes that *S. graminicola*, (Ces.) Sacc. may be identical with *C. Bromi*, Jennings, an undescribed species on *Bromus secalinus.*

Arbor-vitæ—The Western. (Gard. and For. iv. 109, 110, fig. 23).

A description of *Thuja gigantea*, with illustration of base of the trunk and account of the confusion in its nomenclature with *Libocedrus.*

Aster macrophyllus. (Gard. and For. iv. 88, 89, fig. 18).

Blackberry Rust—Perennial Mycelium of the Fungus of. F. C. Newcombe. (Journ. Mycol. vi. 106, 107, Pl. v, vi).

Description and representation of *Cœoma nitens.*

Black Knot of Plum and Cherry Trees. Byron D. Halstead. (Bull. No. 78, N. J. Agric. Enp. Sta., illustrated).

This is an appeal for the destruction of such trees or parts of trees as may have become infested with this fungus (*Plowrightia*

morbosa). The wild as well as the cultivated species of *Prunus* seem to be susceptible to it, and heroic treatment by knife, axe and fire, is urged.

Buffalo Berry—The. (Vick's Mag. xiv. 87, 88, illustrated).

Contains a figure of fruiting branch of *Shepherdia argentea.*

Cnicus Hillii. Wm. M. Canby. (Gard. and For. iv. 101).

Description of a new species, allied to *C. odoratus,* from the borders of Lake Michigan.

Coscinodisceæ—The. Notes on Some Unreliable Criteria of Genera and Species. J. D. Cox. (Reprint from Proc. Am. Soc. Micros., Thirteenth Ann. Meeting, 1890; pp. 184-204, illustrated).

This article is primarily a protest against the unnecessary multiplication of Diatom species founded upon insufficient characteristics or hasty observations. Darwin is quoted to the effect that "one expert has made no fewer than thirty-seven species of one set of forms which another arranges in three." The author gives his conclusions in regard to the genus *Coscinodiscus,* which, if his views are correct, will materially diminish the number of its species; although *Actinocyclus Ehrenbergii* is included. The paper is vigorously written, and some of the sentences are worth quoting for the benefit of others besides diatomists. Thus he says: "Instead of waiting for fuller knowledge, observers have run headlong races to publish new genera and species upon a single specimen, or even fragment of a specimen." He also has evidently no great confidence in the artificial keys which have been published—describing them as complicated and delusive—and finally says: "I venture to say that no living student in this department can be sure that he has a new species, (much less a new variety) before him. The impossibility of being certain leads an observer to solve his doubts in favor of his own discovery, and the same object is named and renamed." Coming as this does in connection with the author's other paper on "Deformed Diatoms," we have an exceedingly interesting and timely contribution. A. H.

Cycadinocarpus Chapinii. (Trans. Meriden Sci. Assn. iv. 62, illustrated).

Description and figure of a new species, the discovery of which was announced in the Transactions for Jan., 1886.

Dewberries—More About the. L. H. Bailey. (Am. Gard. xii. 82–84, figs. 1, 2, 3).

A new variety is figured and described, viz : *Rubus Canadensis*, var. *invisus*, in regard to which the author says: "This variety grows in open woods here at Ithaca, where it looks very different from either *Rubus Canadensis* or *R. villosus*. Professor Dudley, who has given it considerable attention, thinks that it may be found to possess sufficient distinctness to make it worth specific rank. It is certainly more unlike the type of *R. Canadensis* than is the var. *roribaccus*. There is a key at the end, in which the author makes three divisions of our *Rubi*, viz.: Dewberries, Blackberries and Raspberries, and compares the wild with the allied cultivated varieties.

Diatoms—Deformed. J. D. Cox. (Reprint from Proc. Am. Soc. Micros. Thirteenth Ann. Meeting, 1890, pp. 178-183, illustrated).

Abnormalities or sports are described in the genera *Navicula*, *Triceratium*, *Biddulphia*, *Eunotia*, *Licmophora*, *Rhaphoneis*, *Cymatopleura*, *Grammatophora*, *Mastogonia*, *Stictodiscus*, *Coscinodiscus*, *Arachnodiscus*, *Actinoptychus*, *Amphitetras*, *Epithemia* and *Nitzschia*. The author hints at the possibility of abnormalities in structure being more common than generally supposed and that where such abnormalities result in symmetrical markings or outlines new varieties or species may be described from them. In conclusion he says: "Consideration of this sort may assist us in reducing the enormous catalogue of species in the Diatomaceæ, a consummation devoutly to be wished."

Disease of Geraniums. B. T. Galloway. (Journ. Mycol. vi. 114, 115, illustrated).

From preliminary observations the conclusion is reached that this disease is the same as that reported from France, which is said to be caused by a *Bacillus* and which has received the provisional name of *B. caulicolous*, Pr. and Del.

European Aliens in America. D. T. A. Cockerell. (Journ. Bot., xxix. 76–78).

The following species are mentioned: *Ranunculus acris*,

Nasturtium officinale, Capsella Bursa-pastoris, Saponaria Vaccaria, Malva rotundifolia, Trifolium pratense, T. repens, T. hybridum, Medicago lupulina, M. sativa, Sonchus oleraceus, Arctium Lappa, Chrysanthemum Leucanthemum, Convolvulus arvensis, Plantago major, P. lanceolata, Chenopodium album, Polygonum aviculare, P. Convolvulus, Cannabis sativa, Phalaris Canariensis, Phleum pratense, Setaria viridis and *Dactylis glomerata.*

Ferns—The Geological History of. Edward Orton. (Journ. Columbus Hort. Soc. v. 96, 97).

Abstract of address at meeting of Oct. 25th, 1890.

Ferns—The Multiplication of. Freda Detmars. (Journ. Columbus Hort. Soc. v. 97–99, Pl. vii).

Contains full page representation of *Camptosorus rhizophyllus.*

Field Notes.—1890. Erwin F. Smith. (Journ. Mycol. vi. 107-110).

These are a series of notes or memoranda upon Peach Leaf Curl, (*Taphrina deformans*); Plum Taphrina, (*T. Pruni*); Plum Blight; Apple Blight, (*Bacillus amylovorus*); Pear Leaf Blight, (*Entomosporium maculatum*); Black Rot, (*Læstadia Bidwellii*); Vine Blight, the effects of which, in some places, were popularly attributed to lightning; Brown Rot of the Peach, (*Monilia fructigena*); Peach Yellows and the Peach Rosette.

Flora of the Great Falls Coal Field, Montana—The. J. S. Newberry. (Am. Journ. Sci. xli. 191-201, Pl. xiv.)

In this paper the author describes the following seven new species, all figured: *Chiropteris Williamsii, C. spathulata, Zamites apertus, Baiera brevifolia, Cladophlebis angustifolia, Sequoia acutifolia* and *Podozamites nervosa.* Dr. Newberry also discusses the relationship existing between the Great Falls beds, the Kootanie Group of Canada, the Kome Group of Greenland and the Potomac Group of Maryland, with the conclusion that they are all Cretaceous and antedated the Amboy clays, Dakota sandstones and Laramie Group which followed in the order named.

A. H.

Flora of Richmond County, N. Y.—Additions to the. Arthur Hollick. (Proc. Nat. Sci. Ass. S. I., Jan. 10, 1891).

Among the nineteen additions noted the members of the

Torrey Botanical Club are credited with having found seven, during the several field day excursions to Staten Island.

Fossil Woods and Lignites from Arkansas—Description of. F. H. Knowlton. (Reprint from Ann. Rept. Geol. Surv. Ark. for the year 1889; ii. 249-267, Pl. ix., x., xi.)

In this paper the author has given us still further proof of the value of his microscopic examinations of fossil woods. The specimens in question are from the Eocene Tertiary of Arkansas and the following are described and figured as new species: *Cupressinoxylon Arkansanum, C. Calli, Laurinoxylon Branneri* and *L. Lesquereuxiana.* A. H.

Leptothyrium periclymeni, Desm. J. B. Ellis and B. M. Everhart. (Journ. Mycol. vi. 116).

Note upon a new variety of this species (var. *Americanum*) on a *Lonicera* found in Ontario, Can.

Mina lobata. (Garden, xxxix. 144, 145, Pl. 792).

Notes on North American Trees—XXIV. C. S. Sargent. (Gard. and For. iv. 100).

Memorandum upon the difference between *Hypelate trifoliata* and *H. paniculata,* which latter the author shows should be known as *Exothea paniculata,* Radlk. There is also brief reference to *E. Copallilo.*

Orchids of New England—The Native. Walter Deane. (Am. Gard. xii. 152–157, figs. 1, 2, 3, 4, 5).

The following species are figured: *Habenaria fimbriata, H. dilatata, H. tridentata, Liparis liliifolia, Calypso borealis* and *Aplectrum hyemale,* the figures being taken from Mr. Baldwin's work on the same subject.

Passiflora racemosa. (Garden, xxxix. 168, 169, Pl. 793).

Pear Disease—A New. B. T. Galloway. (Journ. Mycol. vi. 113, 114).

Note upon *Thelephora pedicillata,* which is also said to be found upon such widely separated genera as *Quercus coccinea* and *Sabal Palmetto.*

Plants which Grow About Lynn, North Carolina. E. H. Horsford. (Gard. and For. iv. 86).

Prunus ilicifolia, var. occidentalis. Geo. B. Sudworth. (Gard. and For. iv. 51).

There has been trouble in regard to the correct nomenclature of this plant, due primarily to what was probably a mistake of Mr. W. S. Lyon, who published the first account of it and referred it to *Prunus occidentalis*, Nuttall, a name which subsequent research has failed to find in Nuttall's writings. T. S. Brandegee and C. S. Sargent agree in referring it to *P. ilicifolia*, Walp. var. *occidentalis*, (Lyon) T. S. B. The author now calls attention to the fact, however, that this name was applied by Swartz in 1800 to a West Indian species of the genus, which would debar its use for the plant in question, and this leaves it without any name. That of *Prunus ilicifolia*, var. *integrifolia* is therefore proposed.

Puccinia and Phragmidium—The Relationship of. G. De Lagerheim. (Journ. Mycol., vi. 111-113).

Rhamnus Californica and its Allies. Katharine Brandegee. (Zoe, i. 240–244).

Sarcodes sanguinea, Torr. F. W. Oliver. (Annals of Bot. iv. 303–326, 5 plates).

Prof. Oliver has made an exhaustive study of the "Snow-plant" of California from specimens collected near San Bernardino, by Messrs. Godman and Elwes. The vegetative and reproductive organs are described in detail. The roots were found to be densely covered with fungal mycelium, forming a mycorhiza, resembling that found on those of *Monotropa*, with which genus the plant is otherwise compared. Both are regarded as saprophytes or humus plants.

Sleepy Grass—The. V. Havard. (Gard. and For. iv. 111).

Describes the narcotic effect of *Stipa viridula*, var. *robusta* on horses.

Sphenophyllum—The Genus. J. S. Newberry. (Reprint from Journ. Cinn. Soc. Nat. Hist., Jan. 1891, 212–217, Pl. xix).

Dr. Newberry discusses the probable affinities of the genus *Sphenophyllum*, and concludes that it represents a peculiar and extinct family whose nearest relative is *Equisetum*. The fact is also pointed out that as early as the year 1853 the author described and published his ideas relative to the undoubted unity of the genera *Asterophyllites* and *Sphenophyllum*—the former representing the submerged capillary leaves, and the latter the

broad emerged leaves of the same plants, although subsequent authors failed to note the priority of these views while laying claim to the same observed facts. Six species from American localities are described. The illustrations are designed to show the diversity in the vegetative organs. A. H.

Spiraea Aruncus. (Garden, xxxix. 185, figure).

Sporophyte—Sexual Immobility as a Cause of the Developement of the. Conway MacMillan. (Amer. Nat. xxv. 22–25).

The Forest in one of its Relations to the Orchard. Byron D. Halsted. (For. Leaves, iii. 68-70).

In this article the author points out the connection between the "cedar-galls" and the accompanying rusts or smuts by which they manifest themselves on the trees of the orchard. The "black knot" also receives attention.

Uredineæ and *Ustilaginæ—Notes on certain.* F. W. Anderson. Journ. Mycol. vi. 121–127).

Notes are given under the genera *Æcidium, Puccinia, Triphragmium, Uromyces, Entyloma* and *Uredo. Æcidium Palmeri* is described as a new species, and *Puccinia Windsoriæ*, Sch., var. *australis*, as a new variety.

Uredineæ and *Ustilagineæ—New Species of.* J. B. Ellis and B. M. Everhart. (Journ. Mycol. vi. 118-121).

Eleven new species are described under the genera *Schræteria, Schizonella, Ustilago, Æcidium, Uromyces* and *Puccinia.*

Uromyces auf Glycyrrhiza in der alten und in der neuen Welt. — Ueber des Auftreten eines. P. Magnus. (Ber. Deutsch. Bot. Gesell. viii. 377-384; one plate).

Ustilago from Florida—A New. J. B. Ellis and F. W. Anderson. (Journ. Mycol. vi. 116, 117).

Ustilago Nealii is described as new.

Wild Fruits—Promising—IV. A. A. Crozier. (Am. Garden, xii. 16-20).

Notes upon *Amelanchier Canadensis*, var., *Morus rubra, Gaylussacia*, sp., *Vaccinium*, sp., *Juglans nigra, J. cinerea, Hicoria ovata, H. sulcata, H. Pecan, Corylus Americana* and *C. Avellana.*

Winter Aspect of Trees. J. Walton. (Vick's Mag. xiv. 76–79, illustrated.)

In this article we have pictures meant to represent the leaf forms and branching of *Quercus alba*, *Q. coccinea*, *Q. tinctoria*, *Ulmus Americana* and *Pyrus Malus*.

Proceedings of the Club.

WEDNESDAY EVENING, FEBRUARY 25TH.

The Vice-President, Dr. T. F. Allen, in the Chair and twenty-three persons present.

Miss Jeannette Clenan and Mrs. J. K. Cilly were elected active members.

Dr. Rusby and Dr. Morong were appointed delegates to represent the Club at the proposed conference of members of the scientific societies of New York City.

Reports were received from the Committee on Instruction and from the Field Committee of 1890.

Dr. Britton remarked on a *Vaccinium* observed by him on the excursion of July 4th. to High Point, N. J., which appears to be *V. Pennsylvanicum*, var. *nigrum*, Wood. He stated that the same plant had been collected and repeatedly observed on the Pocono plateau of Pennsylvania by Dr. Porter, and that it was pretty clearly a distinct species. He also alluded to *Vitis Solonis*, Planch., collected by Dr. Porter at Easton, Penn., and *Vitis Virginiana*, Munson, recently described from West Virginia, two grapes not alluded to in recent manuals of botany, but which claim recognition as species or varieties. *Vitis rupestris*, Scheele, a southwestern species, has been found by Dr. Porter in southern Pennsylvania.

TUESDAY EVENING, MARCH 10TH.

Dr. Thos. Morong in the Chair and thirty persons present.

Dr. Washington Matthews of Fort Wingate, New Mexico, was elected a corresponding member.

Dr. Britton delivered the announced lecture for the evening on "Grasses." The address was profusely illustrated by lantern slides.